Top Lang Disorders
Vol. 26, No. 1, pp. 70–84

Assistive Technology and Literacy Partnerships

Yvonne Gillette, PhD

Assistive technology (AT) has the potential to support the literacy skills of students with disabilities as they participate in the general education curriculum. Empirical evidence is presented to support the use of AT, at least for some students. A case study interwoven within the article illustrates team decision-making regarding software and hardware options for reading and writing skill support. Today's technology can support students with needs in reading, understanding curricular materials, and in writing skills, such as planning, drafting, editing, and publishing. The need for expertise in AT and team knowledge of the student, the environment, and the curriculum is emphasized. The case study illustrates how positive outcomes can result from team collaboration, involving the student, the family, special education and general education teachers, and school administrators.
Key words: *assistive technology*, *collaboration*, *individualized education program teams*, *literacy*, *reading*, *software*, *writing*

THE term "*assistive technology*" ("*AT*") often frightens otherwise competent interventionists who lack confidence in their knowledge of AT and are only minimally aware of its potential for addressing diverse language–literacy needs, as well as the needs of individuals with severe motor–speech impairments. The term AT also may conjure up images of long stretches on hold with a help desk, attempts to read unintelligible manuals, and discovering incompatibilities between software and existing computers. Recent advances in software development and broader definitions of AT, however, have removed some of the mystery from the process, making it easier for nonexperts to consider AT supports as part of comprehensive language–literacy interventions for students with special needs. This article describes how collaborative educational teams might work with families to design effective assessment and interventions by employing AT to support literacy development and use.

From the School of Speech-Language Pathology and Audiology, University of Akron, Akron, Ohio.

Corresponding author: Yvonne Gillette, PhD, School of Speech-Language Pathology and Audiology, University of Akron, Akron, OH 44325 (e-mail: yg@uakron.edu).

The Individuals With Disabilities Education Act has required that AT services and devices be considered on every individualized education program (IEP) since the law was reauthorized in 1997 as Pub. L. No. 105-17 (Individuals With Disabilities Act [IDEA] Amendments, 1997). According to the most current reauthorization as the Individuals With Disabilities Education Improvement Act (2004, Pub. L. No. 108-446, Title I, Part A), *AT device* means

> Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability (Pub. L. No 108-446, § 602 (1)).

AT service is defined as "Any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device" (Pub. L. No. 108-446, § 602 (2)).

Educational teams can develop collaborative partnerships for securing AT and providing the needed services to address the literacy concerns of all their students, including those with the most complex needs. The guiding principles and strategies for forming and implementing these partnerships are illustrated

with a case example of a boy named Lewis (pseudonym).

INTRODUCING LEWIS

Lewis, diagnosed with a learning disability (LD), was essentially unable to read the textbooks used for his seventh-grade classes. The Weschler Individual Achievement Test, Second Edition (WIAT-2), indicated that he was functioning at a grade equivalent score of 2.8 in word reading and at a 3.5-grade equivalent score in reading comprehension. Consequently, his IEP goals addressed skills in reading decoding and comprehension. Interestingly, however, his IEP goals did not address writing skills despite a 4.2-grade equivalent score on the written expression and spelling portions of the WIAT-2 and functional performance characterized by a restricted range of sentence structures and extensive spelling and grammatical errors. A final note stated that, given these skill levels, Lewis would have difficulty with grade-level written assignments.

Lewis' educational team included Lewis, his mother, his special education teacher, classroom assistant, general education language arts teacher, speech–language pathologist (SLP), and the school principal. The SLP served as the facilitator, which worked well because she communicated effectively with his mother, regularly provided intervention in Lewis' resource room and some of his general education classes, and knew all of his teachers well. Typically, the team met annually, but a concern arose during the seventh-grade year. At that time, Lewis' mother asked the SLP for an additional meeting because, along with the special education teacher and the SLP, she was concerned about the level of Lewis' literacy skills. Although he was motivated to learn and could articulate his learning difficulties, Lewis was beginning to express frustration with his limited progress. At this smaller group meeting, Lewis' mother requested that his service team explore the use of technology because none of the interventions it had tried seemed to be working for Lewis.

EVIDENCE FOR THE USE OF TECHNOLOGY IN LITERACY INTERVENTION

Although more studies are published each year regarding the effectiveness of various technologies for literacy, finding a study that matches the characteristics of a particular student can be a challenge. A blanket statement on the effectiveness of technology also is inappropriate, because recent reviews (e.g., Sitko, Laine, & Sitko, 2005; Strangman & Dalton, 2005) include both negative and positive findings.

With regarding to reading, one study was a particularly good match for Lewis' reading needs. The study investigated the use of AT with 18 average and 18 less-skilled readers in eighth and ninth grades (Montali & Lewandowski, 1996). Three experimental conditions were compared: visual presentation (on-screen silent reading); auditory presentation (digitized voice); and bimodal presentation (digitized voice with word highlighting) at each of three 30- to 40-min sessions. Reading comprehension results indicated that the less-skilled readers understood more information in the bimodal presentation than in the unimodal presentations and performed similarly to the average readers when using the visual condition only. In word recognition, the less-skilled readers showed improved decoding skills across all conditions. Student responses to a brief survey indicated that less-skilled readers felt more successful with the bimodal presentation.

In contrast to reading, more research and descriptive reports are available regarding the use of technology to support the writing skills of Lewis, the case example. Writing skills and processes that have been facilitated through technology include text organization, vocabulary, content, form and syntactic maturity, editing, spelling, punctuation, capitalization, and length of composition (e.g., MacArthur, 2000; Nelson, Bahr, & Van Meter, 2004; Sturm, Rankin, Beukelman, & Schutz-Meuhling, 1997; Sturm & Rankin-Erikson, 2002). Variations among program

types, student keyboarding ability, motivation, and technology knowledge can affect outcomes. It is difficult to find wide-ranging empirical evidence for any one type of technological support.

Word processing with or without speech feedback appears promising for student writers, but keyboarding skill can affect outcome, and word processing alone is not a magical solution. For example, in a 3-week study of 11 fifth- and sixth-grade students with LD, MacArthur and Graham (1987) compared handwritten and word-processed compositions and found no differences in overall quality, length, or proportion of spelling and capitalization errors. They also reported no differences in story structure, vocabulary, or syntactic structure. In constrast, Owston and Wideman (1997) conducted a 3-year study, in which they compared students in Grades 3 through 5 having high computer access over all 3 years, with students having low computer access. After an opportunity for extended practice, students with high computer access scored significantly higher on a holistic measure of essay meaning, content quality, quality of form, and surface structure. More recently, Hetzroni and Schrieber (2004) compared the performance of junior high school students with LD with and without computers using an ABAB design, across 36 to 38 sessions. Students who used computers produced fewer spelling errors and achieved higher overall quality scores for organization and structure. Taken together, these studies suggest that long-term use of computers may have more positive effects on student writing than do interventions of brief duration.

Computer-based concept maps for planning and organizing writing also appear to have potential for improving student writing, especially at the discourse level. In a study conducted by Sturm and Rankin-Erikson (2002), 12 eighth-grade students with reading difficulties composed descriptive essays during a 2-week period under three conditions: no support from a concept map, handwritten concept map support, and computer-based concept map support. Students received writing instruction during this period as well. Students under both the hand-drawn and the computer-generated map conditions produced higher numbers of words, T-units, and attained higher holistic essay scores than students using no supports. Student attitudes toward writing were also more positive in the computer-based concept map condition.

Several studies support the use of technology for enhancing spelling skills. Lewis (1998), for example, who conducted studies on 4th- to 12th-grade students with and without LD, found the greatest benefit with school-age students with LD in the area of spelling. Blischak and Schlosser (2003) compared the effects of speech feedback, print feedback, and print–speech feedback on spelling skills of five children with autism between the ages of 8 and 12 who were nonspeaking but had limited spelling ability. Of the five, three achieved greater success with print-alone or print–speech feedback; two attained greater gains with the speech-alone or print–speech options. Finally, MacArthur, Graham, Haynes, and De La Paz (1996) found that students in the aided spellcheck condition corrected more errors than those in the unaided condition. However, the authors noted that a high rate (63%) of spelling errors remained uncorrected.

Word/grammar prediction options also may be used to support spelling or grammar choices. The difference between word prediction and spellcheck features is that word prediction programs generally offer choices in a small window that change as the student types in additional letters; spellcheckers typically require activation by users after words are entered. Word prediction may save keystrokes in that students may opt to enter the full word into their document with one keystroke at the point they notice that the intended word has appeared. There is a question, however, of whether the presence of the word prediction window widens the divide in the student's attention between the word choices and the ongoing work of creating

an organized composition, or whether word prediction has the intended effect of supporting word production so that increased attention can be directed to the composition processes at higher levels. Word prediction programs vary in the number of words in their spelling dictionaries (ranging from 300- to 10,000-word vocabularies). Some also predict grammatically correct choices for parts of speech on the basis of their position in sentences, and some offer speech feedback as support for reviewing the list of potential options.

A review of research on the effectiveness of word prediction for supporting writing reveals varied results (MacArthur, Ferretti, Okolo, & Cavalier 2001). Williams (2002) reported data on the basis of 51 journal entries for a seventh-grade student with LD using Write OutLoud (Don Johnston Incorporated), a talking word-processing program with Co:Writer (Don Johnston Incorporated), a word/grammar prediction program. Using these programs, his compositions were longer, increasing from a baseline performance level of 36.9 words to an average of 60.28. In addition, the student's essays increased a full point on a 7-point holistic writing rubric that included spelling as well as other writing considerations.

Although evidence for the use of AT to improve student writing is mixed and cannot be considered to offer a panacea, teams should consider these interventions, especially when students are not successful using paper/pencil approaches. Several studies have emphasized the predominance of individual differences in response to AT supports (e.g., Blischak & Scholsser, 2003; Montali & Lewandowski, 1996). Thus, individualized planning sessions are needed to review each student's ability and motivation to use computers. Plans also should include training opportunities for families and staff. Comprehensive instruction, along with appropriate technology, may make a difference in the writing skills of any student.

TEAMS AND ASSISTIVE TECHNOLOGY: DESIGNING EFFECTIVE SERVICES

Current policy indicates that IEPs should be established by teams and that teams should include the student, parents, educators, and others knowledgeable about the student's special needs. As noted previously, current policy also requires that AT devices and services be considered and provided as part of a free and appropriate public education. Developing and implementing a coordinated approach takes collaboration among members of a group and a mutual acceptance and understanding that members vary in the knowledge they have about the student, AT, the disability, and the curriculum. Teams considering AT may reach any of four possible conclusions (Bodine & Melonis, 2005):

1. Current interventions (whether no tech, low tech, or high tech) are working and nothing new is needed, including AT.
2. AT already has been selected (or there has been a trial with AT) and it is known to work.
3. New or different AT should be tried.
4. The IEP team does not know enough to make an immediate decision. In this case, more information must be obtained, typically through an AT evaluation process (adapted from www.wati.org).

Before teams can make such decisions effectively, quality services must be in place, and collaboration is a key to providing quality AT services (Hutinger & Johanson, 2000; MacGregor & Pachuski, 1996; Todis & Walker, 1993). To assess other indicators of service quality, Zabala and Foster (2005; Quality Indicators for Assistive Technology Services, 2005, http://www.qiat.org) have developed a set of indicators that should be considered when assessing AT needs; documenting AT needs in IEPs; implementing services; evaluating effectiveness; planning for transition; offering professional development and training; and garnering administrative support. A common theme across all of the quality categories

is collaboration, including shared responsibility; access to the general curriculum; data collection and documentation; knowledge of the student and the environment; funding; and the availability of training.

DEVELOPING A NEW LITERACY PLAN FOR LEWIS

Lewis' limited progress, using current literacy interventions, such as his current reading system and books on tape, prompted his mother's concerns. Interventions for addressing the word reading difficulties included practice reading word lists provided by various interventionists, accompanied by assignments, which were lists of words from his reading that he was to divide into syllables. The plan also called for Lewis to learn improved strategies for using context to identify unknown words. Finally, reading comprehension was addressed through exercises that involved answering questions about text content. Although it was not part of the original intervention plan, the SLP urged the team to consider his writing problem because of its potential influence on his ability to progress in later grades and because of known linkages between reading and writing (e.g., Catts & Kamhi, 2005; Ehri, 2000). Even though no writing interventions were specified on the IEP, the team reviewed writing samples Lewis had produced for various curricular assignments to assist it in planning to meet his overall literacy needs. Figure 1 presents one such example.

On the basis of its review, the team made several observations: (1) Lewis' written efforts were brief, especially given the time spent producing the work; (2) his writing was not as sophisticated or extensive in content as his spoken language; and (3) his work contained many errors in spelling, capitalization, and punctuation that detracted from its meaning. As the facilitator, the SLP sought Lewis' perspective on his current plan. Lewis told her (1) he did not feel he was making progress with the Wilson Reading System; (2) he did like books on tape, but he often lost his place when he needed to rewind and find information he needed to review for comprehension questions; (3) he did not understand why he had to do syllabication exercises and did not find these helpful; and (4) he did not understand why he produced so many errors while writing. He was frustrated and wanted to try technology to help him with his writing. The team concluded that this would be an important addition to his IEP.

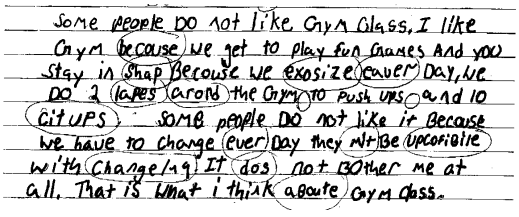
Some people DO not like Gym Class, I like Gym because we get to play fun Games And you Stay in Shap Because we exosize every Day, we DO 2 laPES arond the Gym to push ups and 10 Cit UPS . SOME people DO not like it Because we have to change ever Day they mt Be Uporiable with Change/ng IT dos not BOther me at all. That is what i think about Gym Class.

Figure 1. A corrected sample of Lewis' writing.

The SLP reported the conclusions of the smaller group's analyses to the principal, and together, they concluded that the services of an AT specialist would be helpful at this point. The SLP and the principal selected a local AT specialist to complete an evaluation based on the criteria identified by Moore-Brown and Montgomery (2001) and Zabala and Foster (2005) as an individual having: (a) expertise about AT for reading and writing; (b) familiarity with several specific programs; (c) access to a variety of software programs; (d) willingness to design an assessment and intervention plan for the natural environment; (e) commitment to provide a written report with purchasing information for any AT that was recommended; (f) expertise needed to install the AT system; and (g) availability to provide software use training to the staff.

COMPONENTS OF AN ASSISTIVE TECHNOLOGY EVALUATION

Although other models of AT assessment exist, three are described here (Reed & Lahm, 2004; Scherer, 2005; Zabala, 2005). The first model is part of the Wisconsin Assistive Technology Initiative (WATI, 2004; Reed &

Table 1. The scope of the WATI assessment plan

Gathering information	Gather information Schedule an initial team meeting
Decision making	The team: –identifies the problem –prioritizes the list of tasks –generates solutions (brain storming) –selects a solution –implements the assessment plan
Trial use	Implement planned trials Follow up on planned data and plan for permanent use

Note. The table is a summary of guidelines from pp. 16 and 17 of the Wisconsin Assistive Technology Initiative. (2004). *W.A.T.I. Assessment Package*. Retrieved January 4, 2006, from http://www.wati.org/products/freematerials.html

Lahm, 2004) and involves a 9-step approach to AT assessment within three categories: gathering information, decision making, and trial use (see Table 1 for more details). Advantages of the WATI model include the direct involvement of the team in all phases of the evaluation, selection, planning, and follow-up processes. Teams can use this process free of cost by downloading the 2004 W.A.T.I. Assessment Package from the Web site, www.wati.org. Although the assessment form is 37 pages long, teams can elect to use only those pages that apply to the student being assessed.

The second model, proposed by Zabala (2005), recommends gathering data in four areas: *student*, *environment*, *tasks*, and *tools* (SETT). The SETT framework is specific to the school setting and uses questions across the four areas to guide logical decision making. Table 2 illustrates the SETT process with assessment information gathered about Lewis.

The third model, Scherer's (2005) Matching Persons to Technology (MPT) model, guides teams to consider an individual's milieu or environment, sensory–motor skills and needs, functional needs across daily activities, personality and temperament, and the characteristics of the AT itself. Scherer's questionnaire includes an item on reading and writing, which is focused primarily on everyday living activities (e.g., household, self-care, and social recreational tasks) rather than on academic uses of AT. A main contribution of this model is its consideration of attitude, personality, and temperament as important factors that affect the acceptance and use of technology; technology alone is never the answer to improved quality of life.

A side-by-side comparison of the three models reveals that all assume that someone on the team has knowledge of a variety of AT devices and access to AT products. None of the models identifies specific programs or devices for trials (Zabala & Foster, 2005). One reason for this situation may be that constant evolution of technology soon renders any specific list obsolete. Therefore, teams often are asked to consider desirable features and encouraged to consult other resources that can be updated frequently (e.g., Web sites) about specific products. A list of potential resources is included in the Appendix.

It is an added plus if a team member has knowledge of off-the-shelf technology, because many standard programs offer reading and writing assistance that may be extensive enough for the needs of some students. Generic technology is frequently less costly because it has a wider market. It also may be less stigmatizing (Parette & Scherer, 2004). Further, such technology already may exist in a school's computer laboratory or be readily available on a district server, and thus, may be used by whole classes at the same time.

What these three models provide is a system for gathering information from the multiple stakeholders in the decision-making process. In addition to the AT specialist's expertise, teams need information from those who are knowledgeable about a specific student's abilities and needs. Teachers, parents, significant others, as well as students

Table 2. Example of SETT assessment considerations applied to Lewis

Factors	Considerations for Lewis
The student	Needs to read and write more effectively.
	Currently reads and writes well below grade level.
	No other special needs noted.
The environment	Environments include a resource room and general education classes across the curriculum.
	The special education room and the library have computers with printers and sound cards.
	General education programs provide primary instruction.
	Resource room provides support from computers, as well as the special education teacher and the classroom assistant.
The tasks	Reading and writing occur across the curriculum.
	Current interventions, such as his current reading system and books on tape, have not been effective.
	Access to more or different AT may provide more useful support.
The tools	Options considered include text-to-speech reading programs, talking word processors, and composition planning programs.
	AT trials initially can be conducted in the resource room; later, the plan may be to include AT in his general education classes.

Note. SETT = student, environment, tasks, and tools; AT = assistive technology. Adapted from Zabala, J. S. (2005). *The SETT framework: Critical areas to consider when making informed assistive technology decisions*. Retrieved November 30, 2005, from http://www2.edc.org/NCIP/workshops/sett/SETT_Framework_article.html

themselves can provide essential information on students' needs, attitudes, and traits related to technology; the environment; the tasks; and existing technology tools. When combined, these multiple perspectives can lead to the best possible AT solutions for meeting a student's particular needs.

DETERMINING THE ASSISTIVE TECHNOLOGY OPTIONS TO EXPLORE WITH LEWIS

As the facilitator for Lewis' IEP team, the SLP drew procedures from each of the three AT decision-making models and reviewed writing instruction guides (e.g., Nelson et al., 2004). She gathered information from other members of the smaller group (i.e., mother and special education teacher) and then scheduled a meeting to form a common goal: find Lewis a method to improve his functional, independent reading and writing skills. They also determined the need for an AT specialist to participate on the team, identified an individual who was agreeable to the school administration, and outlined a set of responsibilities for the AT specialist. These included an initial review of his current plan and the use of dynamic assessment to design a 1-month trial with the software and hardware.

For reading, the AT specialist suggested eliminating books on tape and other audio-only technology because Lewis said he did not benefit from these approaches. Because Lewis said that he wanted something to look at as well as hear, optical character recognition (OCR) programs with speech synthesis were explored. These programs read each word aloud while visually highlighting each word spoken. The AT specialist noted that while some programs are marketed specifically for reading, talking word processors can also work effectively for reading any digitized text. This includes text that is copied from the Internet and pasted into the

program, or materials that are scanned with OCR software.

The AT specialist's list for reading included Write OutLoud (Don Johnston Incorporated), Read OutLoud (Don Johnston Incorporated), and Kurzweil 3000 (Kurzweil Educational Systems), all three of which required a scanner. Write OutLoud (Don Johnston Incorporated) and Read OutLoud (Don Johnston) required OCR software so that the material to be scanned could be digitized and read aloud by the computer. Also noted by the AT specialist was that generic OCR software was included with most scanners, but could be difficult to figure out for those inexperienced with technology. Kurzweil 3000 (Kurzweil Educational Systems) included OCR software, which could simplify the process.

In terms of writing, the AT specialist's suggestions focused on the organizing and planning aspects of written composition. Again, visual supports such as webbing and outlining were considered to provide Lewis with additional scaffolds. For drafting, speech output was an option to provide him with visual as well as auditory input for monitoring his work in two modalities. The AT specialist pointed out that features of standard and talking word processors, such as spellcheck, grammar check, and thesaurus, could provide assistance with revising and editing. Other features of these word processors addressed publishing issues such as font and text size, color changes, bold and underline, line spacing, and other paragraph formatting features, as well as page set up for margins. The AT specialist considered using the word/grammar prediction software, Co:Writer (Don Johnston Incorporated), coupled with talking word processor software, because it would offer Lewis grammatically based word choices and correct spellings as he typed. However, some research findings suggested that word prediction could distract students from their writing (e.g., MacArthur et al., 2001). Therefore the group members decided to reserve that option for later discussion. Because they agreed that Lewis' spoken language was more sophisticated than his written language, the AT specialist suggested voice recognition (VR) as another possible option. Using VR, Lewis could program the software to type the words he spoke (after a short period of training so it could recognize his speech patterns). Table 3 lists the programs recommended by the AT specialist after this dynamic assessment process of Lewis' reading and writing patterns.

THE SELECTION OF SOFTWARE FOR A ONE-MONTH TRIAL

With the goal of software selection for the trial, the evaluation team was expanded to include the AT specialist, the special education teacher, the SLP, Lewis' mother, and Lewis himself. When the AT specialist presented her final technology options list to this group, she came prepared to make decisions. She had the software, a laptop and a charger, an external mouse, and headphones. She had prescanned a newspaper article on a recent school sporting event familiar to Lewis, had copied a document from the Internet on car repair as a career, and had prepared several comprehension questions with known answers. On the basis of the group's input, she knew that both topic areas would be high-interest reading material for Lewis.

The AT specialist and Lewis sat at his typical worktable in the resource room. She oriented him to the computer by having Lewis try the headphones for sound and typing a few words for speech feedback. She noticed that his keyboard skills were "hunt and peck" and knew that limited keyboard skills would influence the speed of his performance considerably. The pair compared the external mouse with the touchpad on the laptop; Lewis preferred the external mouse because it was familiar. Finally, she inquired whether Lewis would like to learn to type, to which he responded affirmatively. This discussion was used to initiate the collaborative process of evaluation she hoped to establish with Lewis and his educational team.

Table 3. Software and hardware considered for Lewis' reading and writing assistive technology plan

Software	
Reading	Write OutLoud (Don Johnston Incorporated)
	Read OutLoud (Don Johnston Incorporated)
	Kurzweil 3000 (Kurzweil Educational Systems)
Writing	
Planning	Inspiration (Inspiration)
	Draft Builder (Don Johnston Incorporated)
Drafting (talking word processors)	Write OutLoud (Don Johnston Incorporated)
	IntelliTalk III (IntelliTools)
	Word 2003 (Microsoft)
Drafting (voice recognition)	Scansoft Dragon Naturally Speaking (Nuance)
	Word 2003 (Microsoft)
Revising and editing	Write OutLoud (Don Johnston Incorporated)
	IntelliTalk III (IntelliTools)
	Word 2003 (Microsoft)
Publishing	Write OutLoud (Don Johnston Incorporated)
	IntelliTalk III (IntelliTools)
	Word 2003 (Microsoft)
Hardware	
Scanning text for text-to-speech reading programs	Any scanner that includes optical character recognition software, more expensive scanners that have faster software, new and used equipment
Headphones	Any brand or cost, new and used equipment
Computer with sound card	Any brand or cost, new and used equipment. The computer must include a sound card

When the rest of the group members arrived, she told them what to expect. She wanted them to be active participants in the evaluation, by making observations and asking questions as she (1) described how the components of the system worked, (2) provided a demonstration of each program, and (3) summarized the available research for the group's consideration. If the group members determined that an AT program had possibilities, Lewis would briefly try the simplest example of the program type with the desired features under consideration. This sampling process was used with each of the options to select the software for the 1-month trial. The evaluation took approximately 1 hour because Lewis and his group members quickly determined that many of the program types were not appropriate at this point of time. Integrated software packages can support several skills.

READING SOFTWARE

With encouragement, Lewis tried the software for reading a paragraph on car repair and answered a series of comprehension questions posed by the AT specialist. Lewis, thought reading software in particular, would be very helpful to him. After a discussion, the group members agreed that the reading software was worth exploring. They were encouraged by the research results shared by the AT specialist (e.g., Montali & Lewandowski, 1996). The AT specialist, however, cautioned the group members about the time required to scan all of Lewis' textbooks and other reading materials. She showed them an alternative use for the program, in which the reading and writing softwares could be used in conjunction with silent reading. In this approach, Lewis could copy unknown words into the program, and then look up the definition

and pronunciation in the program. The group members decided to include digital reading software on the list for the 1-month AT trial. They knew that they would need to secure headphones and a scanner for the trial. Because they did not have the experience with using a scanner to create readable documents, they requested the AT specialist to assist them in purchase, setup, and operation.

WRITING SOFTWARE FOR PLANNING

The discussion that revolved around the composition planning programs were another matter. Lewis was familiar with nonelectronic planning options, such as concept maps, but acknowledged that he rarely used them to plan and organize his writing because of time constraints in the classroom. The special education teacher agreed that time was a big factor. By the time Lewis finished his webbings, class time ran out and he needed to complete his composition in the resource room. Because he wanted to finish with the class, he had just dropped the planning phase.

The AT specialist introduced the composition planning software, Draft Builder (Don Johnston Incorporated). Although the program provided Lewis with auditory and visual inputs for all of the information, as well as templates to support various types of writing, Lewis seemed overwhelmed. Next, she showed him another tool for planning, Inspiration (Inspiration). This program could help Lewis create concept maps of what he would be writing about or fill in templates created by the teacher. After observing him review a template, and then struggle to enter an idea, the group members decided that this might not be the best time to introduce planning software. He concurred, but agreed to try again once he became familiar with the other types of software.

WRITING SOFTWARE FOR DRAFTING WITH A TALKING WORD PROCESSOR

The first discussion revolved around the talking word-processing systems. The group members concurred that talking word processors had real potential for Lewis, but the special education teacher expressed concern about his lack of keyboarding skills: Would this feature slow down Lewis even more than his current handwriting challenges? Also, they were concerned that a talking word processor would distract the whole class. Lewis solved this problem himself, reminding everyone that headphones could be attached to any computer instead of speakers. The group members noted that Lewis enjoyed working with the keyboard to see and hear what he wrote. He said it felt more like working on a car because, once the pieces were there, you could adjust them until you ended up with something that looked and sounded good. Consensus was reached that a talking word processor would be a part of his 1-month trial. Because a talking word processor can double as a reading program, the group members decided initially to use a single piece of software for reading and writing.

WRITING SOFTWARE FOR DRAFTING WITH VR SOFTWARE

The AT specialist demonstrated the method required for training VR programs to type the words as spoken and also demonstrated a version that she had used previously. The group members found this approach interesting, but Lewis objected. Where would he do this? He thought the noise factor associated with speaking to a computer would be unacceptable for him and disturbing to the class. He did not want to stand out in class by talking aloud to a computer. He also did not want to leave the class in order to write. As a result of these concerns, the group members tabled this idea for later consideration in the event that the AT trial showed the need for a different type of support than the talking word processor offered.

WRITING SOFTWARE FOR REVISING, EDITING, AND PUBLISHING

This portion of the discussion proceeded quickly. The AT specialist typed a short document in the Write OutLoud (Don Johnston Incorporated) talking word processor. She

used this document to show how its software features worked for inserting and deleting information, punctuation, signaling spelling errors, and using the spellchecker to pronounce words. She also illustrated some of the publishing features, such as margin and line spacing changes and font, size, and text color changes. Because a talking word processor was already on the list to be used for drafting, Lewis decided that he would try the features another time when he could pay closer attention to each one. The discussion concluded with the AT specialist providing a preliminary list of software types and examples as well as hardware requirements for the 1-month trial period.

THE IEP TEAM FINALIZES THE ASSISTIVE TECHNOLOGY TRIAL PLAN

Next, the general education language arts teacher and the principal joined the evaluation group for a full-team discussion related to logistics of the trial and the cost involved. In terms of the 1-month AT trial, the ideal situation would have been to provide a laptop that Lewis could use across classes and at home as well. The principal indicated that no laptops were available, and securing funding for a laptop would take time. The general education language arts teacher expressed a concern that the trial would be distracting to the other 24 students in her classroom. Further, she did not have a computer available for Lewis' use on a regular basis. The AT specialist stated that the cost for setting up a station with all the assistive software would be the same for each additional computer. After considering all of these factors, the team decided that the resource room managed by the special education teacher would be the best setting for the initial trial. Lewis agreed. Once the team reviewed the results of the trial, it could consider environmental issues more carefully.

In terms of training the educational team, the AT specialist suggested that she train one person, the SLP, who could then assume the training and technology troubleshooting responsibilities for Lewis and the rest of the team. The SLP was in the best position to evaluate all of the components of the trial because she spent time in all of his classrooms, and therefore could collect and share information across all of his learning environments. In addition, the SLP indicated an understanding that instruction in the use of new technology is most successful when implemented with effective teaching strategies, such as modeling, to show the students how the program works, and then waiting before intervening to allow the students to produce independent work (Gillette, 2003; Kamps, Kravits, & Ross, 2002).

Because Lewis could access an existing computer station in the resource room for trials once he had the headphones, no cost was required for the computer and sound card combination. The lowest cost to run the trials would be $250, which included the cost of headphones ($10), scanner ($139), and Write OutLoud (Don Johnston Incorporated) software ($99). Only one piece of software was needed because most talking word processors can function as a reading or writing program. Software cost could be eliminated during the trial period if the program offered a 30-day trial or if demonstration software was available for trial (Nelson et al., 2004). Team members would need to understand that this was an initial trial and that further use would require a purchase and possible upgrades.

Once the principal realized the relatively low cost of the technology, he authorized the team to purchase the full $250 package and implement it for 1 month in the resource room. He also began to appreciate its utility for other students. Lewis' general education language arts teacher expressed skepticism but agreed to follow his progress on the trial. Because she was familiar with his work speed, she was not convinced that he would be able to complete the webbing for classroom projects with pencil/paper and still draft, edit, and publish on the computer. She also thought that using the system for reading would need to be a task that Lewis completed out of the classroom, either in the resource room or at home.

Lewis' mother wanted AT access for Lewis at home if the school trial proved successful. The principal agreed to upgrade the family's home system with the AT supports if the trial indicated the need for a home station with the additional $250 necessary to add the scanner, headphones, and the initial software. The SLP volunteered to investigate the licensing regulations of the software to determine whether the same copy could run at home and school, and the mother said that she would make sure the home computer had a sound card needed to run the voice output of the speakers. All members agreed to have their information ready at the meeting following the 1-month trial, provided the mid-trial progress report indicated that the technology would likely be a useful option for Lewis.

CONCLUDING THE ASSISTIVE TECHNOLOGY TRIAL AND PLANNING FOR INTERVENTION

The AT trial, which included daily reading and writing tasks across the curriculum, was quite successful in terms of Lewis' acceptance of the systems and his motivation. In the writing trial, the special education teacher's data and work samples showed that Lewis' compositions averaged at least 100 words in length, a 50% increase from baseline performance data. In addition, the time spent to complete a one-paragraph composition decreased from 60 to 30 minutes. Spelling errors on his compositions also decreased from an average of 12 per paragraph to 4 or fewer.

In terms of reading, Lewis reported that he read more pages of his school books than he had without the software. Scanning whole pages of text for reading was tedious, so he often entered new words into the Write Out-Loud (Don Johnston Incorporated) to hear the word pronounced along with the definition. He also scanned the introduction, summary, and any question sets he had been assigned from his textbooks. The language arts teacher reported that in regular class assignments, his word recognition and comprehension scores improved from 65% correct to 85% correct and that she found his daily writing easier to read and easier to grade. The entire team agreed that Lewis was beginning to integrate AT into his regular reading and writing assignments across the curriculum.

The special education teacher and the SLP now found themselves in more of a supportive role rather than a remedial role, helping Lewis participate in the typical classroom environment. Because the licensing agreement for the software indicated one installation per computer, the home computer could be upgraded for additional $250. With a way to read and write at home, Lewis could now become more like typical students who went home and did most of their homework independently. Lewis' mother was pleased that she could return to her role as a mother rather than that of a tutor. The principal was pleased with the results of the AT trial and the reasonable cost of making this accommodation for Lewis. He indicated that he would be more open to AT in the future.

The AT specialist reminded the team of several considerations for the future. It needed to plan to teach Lewis keyboarding skills; otherwise, speed of typing might impede further progress. In addition, the team might want to upgrade to a more integrated software package, such as a Kurzweil 3000 (Kurzweil Educational Systems) reader with a high-speed scanner, if it became clear that Lewis would accrue additional benefit from a faster and more sophisticated system. The team also might want to consider purchasing a laptop so Lewis could have access to the same system throughout his day at home and at school. Caveats to such a plan would be additional cost and possible jealousy in the classroom and conflicts on the bus, as well as other risks to the system during transport. The current plan, however, was agreed to be quite successful, and the team decided to continue to collect data to support Lewis' current education plan and prepare for the next IEP meeting. The AT specialist would provide a report that detailed the current plan and provided information for the future.

COLLABORATING, STEP BY STEP

This team followed several key principles of AT collaboration that have been drawn from a variety of sources (Beukelman & Mirenda, 2005; Bodine & Melonis, 2005; Lewis & Doorlag, 2006; Moore-Brown & Montgomery, 2001; Nelson et al., 2004; Rainforth & York-Barr, 1997):

1. The family, the student, and educational professionals were equal team members;
2. Smaller teams/groups took responsibility for some of the initial data-gathering sessions;
3. The team identified an AT specialist with expertise in reading and writing who actively sought its involvement;
4. Decisions were based on the assessment of the student's needs, abilities, and preferences in a typical setting over a period of time;
5. The team worked toward consensus decision making by sharing individual perspectives;
6. The team considered available research and practice evidence in decision making;
7. The plan directly addressed ways to integrate the AT within the context of curricular demands;
8. Plans were established to ensure that all team members had the training and expertise to implement the AT in the context of their teaching and/or intervention roles with the student; and
9. Collaborative problem solving was used to implement AT across environments, taking into account the cost, time, and logistics factors.

Although the initial process of planning for Lewis' AT needs was successful, future needs require consideration for Lewis and others like him. Students with disabilities need individualized plans, and mandates exist to create them. Technology needs for students without disabilities also call for careful attention. As school districts engage in strategic planning, they should develop and implement long-range technology plans that include students with and without disabilities. These plans must include a guiding philosophy as well as attention to operational issues, such as funding for technology and professional development. It is unlikely that the needs of all students will be met unless systemic change occurs.

REFERENCES

Beukelman, D., & Mirenda, P. (2005). *Augmentative and alternative communication: Supporting children and adults with complex communication needs*. Baltimore: Paul H. Brookes.

Blischak, D., & Schlosser, R. (2003). Use of technology to support independent spelling by students with autism. *Topics in Language Disorders*, *23*(4), 293–304.

Bodine, C., & Melonis, M. (2005). Teaming and assistive technology in educational settings. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 209–228). Whitefish Bay, WI: Knowledge by Design, Inc.

Catts, H. W., & Kamhi, A. G. (Eds.). (2005). *Language and reading disabilities* (2nd ed). Boston: Allyn & Bacon.

Ehri, L. C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics in Language Disorders*, *20*(3), 19–36.

Gillette, Y. (2003). *Achieving communication independence.* Eau Claire, WI: Thinking Publications.

Hetzroni, O. E., & Shrieber, B. (2004). Word processing as an assistive technology tool for enhancing academic outcomes of students with writing disabilities in the general classroom. *Journal of Learning Disabilities*, *37*(2), 143–154.

Hutinger, P., & Johanson, J. (2000). Implementing and maintaining an effective early childhood comprehensive technology system. *Topics in Early Childhood Special Education*, *20*(3), 159–173.

Individuals With Disabilities Education Act (IDEA) Amendments of 1997, Pub. L. No. 105-17 U.S.C. 1400 *et seq.*

Individuals With Disabilities Education Improvement Act of 2004, Pub. L. No. 108-446 U.S.C. 1400 *et seq.*

Kamps, D. M., Kravits, T., & Ross, M. (2002). Social-communicative strategies for school-age children. In H. Golstein, L. A. Kaczmarek, & K. M. English (Eds.), *Promoting social communication* (pp. 239–278). Baltimore: Paul H. Brookes.

Lewis, R. B. (1998). Assistive technology and learning disabilities: Today's realities and tomorrow's promises. *Journal of Learning Disabilities*, *31*(1), 16–26.

Lewis, R. B., & Doorlag, D. H. (2006). *Teaching special students in general education classrooms*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

MacArthur, C. A. (2000). New tools for writing: Assistive technology for students with writing difficulties. *Topics in Language Disorders*, *20*(4), 85–100.

MacArthur, C. A., Ferretti, R. P., Okolo, C. M., & Cavalier, A. R. (2001). Technology applications for students with literacy problems: A critical review. *The Elementary School Journal*, *101*(3), 273–301.

MacArthur, C. A., & Graham, S. (1987). Learning disabled students composing under three methods of text production: Handwriting, word processing, and dictation. *Journal of Special Education*, *21,* 22–42.

MacArthur, C. A., Graham, S., Haynes, J. A., & De La Paz, S. (1996). Spell checkers and students with learning disabilities: Performance comparisons and impact on spelling. *Journal of Special Education*, *30,* 35–57.

MacGregor, G., & Pachuski, P. (1996). Assistive technology in schools: Are teachers ready, able, and supported? *Journal of Special Education Technology*, *13*(1), 4–15.

Montali, J., & Lewandowski, L. (1996). Bimodal reading: Benefits of a talking computer for average and less skilled readers. *Journal of Learning Disabilities*, *29*(3), 271–279.

Moore-Brown, B. J., & Montgomery, J. K. (2001). *Making a difference for America's children: Speech-language pathologists in the public schools*. Eau Claire, WI: Thinking Publications.

National Center for Learning Disabilities. (2005). *Learning Disabilities FAQ*. Retrieved December 13, 2005, from http://www.ncld.org/press/NCLDFAQ.cfm

Nelson, N. W., Bahr, C. M., & Van Meter, A. M. (2004). *The writing lab approach to language instruction and intervention*. Baltimore: Paul H. Brookes.

Owston, R. D., & Wideman, H. H. (1997). Word processing and children's writing in a high-computer access setting. *Journal of Research on Computing in Education*, *30*(2), 202–221.

Parette, P., & Scherer, M. (2004). Assistive technology use and stigma. *Education and Training in Developmental Disabilities*, *39*(3), 217–226.

Quality Indicators for Assistive Technology Services. (2005). Retrieved December 13, 2005, from http://www.qiat.org

Rainforth, B., & York-Barr, J. (1997). *Collaborative teams for students with severe disabilities: Integrating therapy and educational services*. Baltimore: Paul H. Brookes.

Reed, P., & Lahm, E. (2004). *Assessing students' needs for assistive technology: A resource manual for school district teams*. Oshkosh: Wisconsin Assistive Technology Initiative.

Scherer, M. (2005). *Living in the state of stuck: How assistive technology impacts the lives of people with disabilities*. Brookline, MA: Brookline Books, Inc.

Sitko, M. C., Laine, C. J., & Sitko, C. (2005). Writing tools: Technology and strategies for struggling writers. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 571–598). Whitefish Bay, WI: Knowledge by Design, Inc.

Strangman, N., & Dalton, B. (2005). Using technology to support struggling readers: A review of the literature. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 545–570). Whitefish Bay, WI: Knowledge by Design, Inc.

Sturm, J. M., Rankin, J. L., Beukelman, D. R., & Schutz-Meuhling, L. (1997). How to select appropriate software for computer assisted writing. *Intervention in School and Clinic*, *32,* 148–161.

Sturm, J. M., & Rankin-Erikson, J. L. (2002). Effects of hand-drawn and computer-generated concept mapping on the expository writing of middle school students with learning disabilities. *Learning Disabilities Research and Practice*, *17*(2), 124–139.

Todis, B., & Walker, H. (1993). User perspectives on assistive technology in educational settings. *Focus on Exceptional Children*, *26*(3), 1–16.

Williams, S. J. (2002). How speech-feedback and word prediction software can help students write. *Teaching Exceptional Children*, *34*(3), 72–78.

Wisconsin Assistive Technology Initiative. (2004). *W.A.T.I. Assessment Package*. Retrieved January 4, 2006, from http://www.wati.org/products/freematerials.html

Zabala, J. S. (2005). *The SETT framework: Critical areas to consider when making informed assistive technology decisions*. Retrieved November 30, 2005, from http://www2.edc.org/NCIP/workshops/sett/SETT_Framework_article.html

Zabala, J. S., & Foster C. D. (2005). Quality indicators for assistive technology services in schools. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 179–208). Whitefish Bay, WI: Knowledge by Design, Inc.

Appendix

Resources for AT

Web sites: Internet sites are more likely to discuss products and versions in current use. It is a good idea to be aware of the date of publication of any technology materials you intend to use for the same reason. However, Web sites are not peer reviewed, so the accuracy of the information reported on the site itself should be viewed with caution. Many of the resources provided by these Web sites do, however, provide peer-reviewed reports.

1. Closing the Gap (www.closingthegap.com): This site offers multiple resources. Subscribers can receive printed information through the monthly newspaper and resource directory and online information with access to archives through a service known as Solutions. A subscription for a combination of print and online information is also available.
2. Coleman Assistive Technology Literature Database (http://www.colemaninstitute.org/database.php): This site provides an AT literature database derived from a collaboration between the Coleman Institute for Cognitive Disabilities, University of Colorado System, and the University of Minnesota Rehabilitation Research and Training Center on Community Living, which is funded by the National Institute on Disability and Rehabilitation Research (NIDRR), U.S. Department of Education. This database allows visitors to identify research articles relevant to their specific needs and also provides a list of journals that may publish articles on AT.
3. LD Online Technology (http://www.ldonline.org/ld_indepth/technology/technology.html#Techtalk): The technology section of LD Online provides technology reviews, guides, resources, guidelines for assessment, online articles, and other useful information specifically related to technology and LD.
4. eSchool News ONLINE (http://www.eschoolnews.com/): It provides a Web site and a daily e-mail newsletter related to technology for general education and students at risk. Because generic technology now offers many features of AT and does so at a lower cost, parents and professionals with special education concerns may find useful resources here.

Books: Books about AT may have inaccurate product information depending on recency of publication; however, depending upon the book, it may provide an excellent source of theoretical support, empirical evidence, and technological know-how that can support the use of AT. An example is

Handbook of Special Education Technology Research and Practice. This 2005 book (published by Knowledge by Design, Inc., http://www.knowledge-by-design.com/), edited by Dave Edyburn, Kyle Higgins, and Randall Boone, includes multiple chapters within sections on history, policy and legal foundations, access for diverse populations, AT, disability-specific technology applications, instructional design, technology and instruction, professional development, and trends and issues.

Internet Sources for Software Cited in the Article

Software programs that can read digitized text

- Write OutLoud (Don Johnston Incorporated Incorporated) (http://www.donjohnston.com/).
- Read OutLoud (Don Johnston Incorporated) (http://www.donjohnston.com/).
- Kurzweil 3000 (Kurzweil Educational Systems) (http://www.kurzweiledu.com).

Software programs that assist students with planning compositions

- Draft Builder (Don Johnston Incorporated) (http://www.donjohnston.com/). Interactive demonstrations available on the Web site include a product demonstration.
- Inspiration (Inspiration) (http://www.inspiration.com/store/main/index.cfm). The Web site includes a product demonstration.

Talking word processors

- IntelliTalk III (IntelliTools) Intellitools (http://www.intellitools.com/): Can be purchased as a part of Classroom Suite. A demonstration disk and online demonstration are available.
- Word 2003 (Microsoft) (http://www.microsoft.com/office/word/prodinfo/default.mspx). An online demonstration and trial version available through the Web site.

Voice recognition software

- Scansoft Dragon Naturally Speaking (http://www.nuance.com/naturallyspeaking/standard/).
- Word 2003 (Microsoft) (http://www.microsoft.com/office/word/prodinfo/default.mspx). An online demonstration and trial version available through the Web site.

Word prediction software

- Co: Writer (Don Johnston Incorporated) (http://www.donjohnston.com).